

Chapter

9

Assessing the Value of Information Technology

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Learning Objectives

Upon completing this chapter, you should be able to:

- Define the terms *productivity* and *performance*.
- Explain why information worker productivity is difficult to measure.
- Discuss ways that information technology can contribute to performance.
- Understand the importance of linking information technology to corporate strategy.
- Point out how factors such as managerial leadership, previous experience with information technology, and user satisfaction can impact performance.
- Differentiate between direct and indirect performance measures.
- List and discuss specific approaches to determining the benefits of information technology.
- Use benefit analysis techniques to calculate the benefits of information technologies.
- Use accepted quantitative techniques to calculate the costs of technologies.
- Given a specific situation, develop a plan to cost-justify EUIS computing expenditures.
- Summarize the key concepts of Information Economics.

9.1 INTRODUCTION

Productivity is a fascinating concept. Debate continues on its definition and on the validity of its measures. Debate continues as to whether or not descriptions of productivity that were developed in factories can be used in the office workplace. Likewise, the relationship between knowledge worker productivity and investment in information technology (IT) is elusive and difficult to determine.

Productivity generally is seen as a means of increasing the bottom line profit of organizations. Organizations make enormous investments in both people and tools. Stephen Roach, an economist with Morgan Stanley Dean Witter, does not believe that investment in technology can be credited with the 5 percent growth in worker productivity achieved in the second half of 1999. He says workers are simply working harder, not better:

Courtesy of laptops, cell phones, home fax machines and other appliances, knowledge workers are now online in cars, planes, trains, and homes, virtually tethered to their offices. The “24/7” culture of nearly round-the-clock work is endemic to the wired economy)

Roach also attributes the productivity increase to cost-cutting measures such as downsizing and outsourcing.

Not everyone agrees with Roach’s analysis. Erik Brynjolfsson (MIT) and Lorin M. Hitt (The Wharton School) say traditional productivity measures are not useful because

they look at the overall economy rather than individual companies.² Others attribute the explosion in productivity to e-commerce. Others say workers are working better, not just harder.

This chapter will look at the issue of knowledge worker productivity, suggesting that performance is a more usable concept than productivity when examining the impact that technology has on work and workers. The need for hard numbers is to justify purchasing technology—to reduce expenses or create a better output—not to measure productivity, per Se.

In this Information Age, more and more attention is being paid to using limited resources efficiently and effectively. Trends toward downsizing (decreasing the number of middle managers) and outsourcing (using outside firms to provide services) attest to this *need*. Organizations are expecting managers to take wider responsibilities. Departments are finding that outside service providers can be more cost effective than internal service providers. Individuals know that to survive (and thrive) in such climates, new work methods may be required. A theme throughout this text is that technology offers an opportunity for enhancing worker performance.

Moreover, technology is viewed here as an important resource that must be managed like any other resource. IT professionals typically view technology investment planning in terms of the costs of hardware, software, and maintenance required. A manager looks at the impact of IT on productivity gains, cost savings, required training, and effectiveness. CEOs are increasingly concerned that they have evidence that IT expenditures will affect the bottom line. However, no one method will provide all this evidence. Decisions to upgrade from one application software suite to another might require a simple cost-benefit analysis. A more complex system might require more sophisticated metrics.³ Yet in other cases, when it is important just to get the new project going, formal analysis is not done.

The chapter's practical aspect is to help managers ask the right questions when trying to cost-justify IT expenditures. Assuming that improved performance is the goal, the cost-justification challenge is to measure the improvement and then translate that benefit into dollars. First, the definition of *productivity* is offered and contrasted with a definition of *performance*. Then, specific measurement techniques related to assigning dollar values to information technology's benefits and costs are offered. These techniques are useful to the manager or planner who must justify IT expenditures. The chapter concludes with an overview of Information Economics (iEcon), an approach to measure the relative value of IT projects and prioritize them.

9.2 PRODUCTIVITY AND PERFORMANCE

The formula for productivity, borrowed from factories and industry, is simple:

Productivity Output/Input

The application of this formula requires an ability to identify and measure inputs and outputs. This is a simple mathematical exercise when applied to factory work. For example, 50 workers each earn \$10 an hour and work 4 hours. **They use** raw materials

worth \$500. They produce 200 widgets, with a profit margin of \$60. Their productivity can be computed as follows:

$$\text{Output} = (200 \times 60) = 12,000$$

$$\text{Input} = (50 \times 10 \times 4) 2,000 + (500) = 2,500$$

$$\text{Productivity} = 12,000/2,500 = 4.8$$

In this case, a planner would show an increase in productivity by demonstrating that workers produced *more* widgets with the same input or produced the same number of widgets with *less* input.

The productivity formula is much more difficult to apply to knowledge work. What is the output of the manager or professional? Is it determined by the number of meetings held, the number of phone calls completed, or the number of reports produced? Is support staff's output the number of letters typed, the number of phone calls handled, or the number of travel plans completed? What are the input resources? Supplies? Time?

The impact of IT on performance, not productivity, is the emphasis in this chapter. Following is a discussion of three key questions related to the relationship of IT and end-user productivity: (1) Does IT contribute to organizational performance?

(2) What key issues or variables are related to information worker performance? and (3) Can performance be measured?

9.2.1 Does Information Technology Contribute to Organizational Performance?

IT produces profit by improving the company's performance in areas that drive profit:

—Robert Benson, Principal of the Beta Group
The issue that most end users and managers consider today is not whether investment *should* be made in IT, but how *much* investment should be made. Researchers have attempted to investigate the impact that information technology has had on the *organization*. Not surprisingly, research findings are mixed. For example, Cron and Sobol found that extensive information technology users were either high or low performers. Harris and Katz found that high performers spent considerably more on information technology than their counterparts. Bender, however, found that information technology was associated with weaker performance.⁵

The premise here is that IT has the potential to increase performance in more ways than simply enabling work to be done faster and/or more easily. IT can support better communications, more informed decisions, and worker creativity. For example, communication technology such as groupware can add synergy to team projects. Decision support systems can help managers make more informed decisions. Hypertext can augment human reasoning, allowing the user to make connections among ideas that were not known before. Project management systems can serve to keep projects on track. Examples of such benefits from IT are discussed throughout this text.

9.2.2 What Are the Organizational and Individual Variables Related to the Impact of IT on Worker Performance That Must Be Understood?

Perhaps the most important factor related to IT success is the need for top management commitment and the tying of technology expenditures to identified goals. In discussing strategic planning in the next part of this text, reference **will be made** to the need for Information Economics. Discussed in detail later in this chapter, the thrust of Information Economics is that information technology must be tied to organizational goals. In other words, technology plans must be linked to strategic plans. At the individual level, technology must be linked to helping the individual work not only faster but also in a way that will increase creativity. Such an approach can provide strong evidence for investment in IT.

Other variables that could have a direct bearing on performance are the organization's experiences with technology and the individual's skill level in using technology. Organizations have not all implemented IT at the same time or infused technology into jobs at the same rate. End users are individuals and therefore do not have consistent skills in using IT. Not surprisingly, organizational experiences with IT and end-user skill levels often are related. Organizations in which users have been using IT for decades typically have workers who are advanced users. Organizations that are just beginning to introduce computing for individuals may be expected to have more novice users. Moreover, organizations in which technology is a long-term investment, not a one-shot deal, have better results.

In addition, it is important to keep in mind that each individual end user has had experiences using IT that enforce either negative or positive perceptions toward its value. Unsuccessful experiences using technology once or twice may translate to technology aversion. On the other hand, successful experiences using technology often breed more successful experiences and the desire to learn more. Technology use and its learning curve are additive; the more one uses IT, the easier it is to use. The more skilled one is in an application, the more likely it is to be used to address specific goals creatively.

9.2.3 Why Measure Performance?

Measuring performance is a difficult and important task. More than 80 percent of the 150 IS executives at U.S. companies reported that they are required to demonstrate the value of IS expenditures.⁶ Sometimes it seems to be intuitive that benefits will accrue from getting users data that will enhance their decision-making abilities or ensure that they don't miss opportunities.⁷ Thus, the challenge for IT planners and managers is not only how to measure performance, but also how to assign a dollar value to any improvement.

Such numbers (dollar values) are important because individuals who decide whether to buy information technologies often must cost-justify the expenditure to upper management. Cost justification is a way of saying that by purchasing such-and-such

technology, we will increase performance by X amount, and that translates into a savings of \$X.

The crux of the problem of assigning dollars to performance improvement is how to apply hard-dollar figures to soft-dollar savings. *Hard-dollar* figures are actual values of benefit gains in dollars and cents. It's worth, however, is frequently measured in *soft-dollar* savings, which implies an intangible value. An intangible value could be the better decision made with an expert system, better customer service, or the impact that an ergonomically designed workstation had on the comfort of the user.

Early efforts in office automation often focused on clerical personnel. It soon became apparent, however, that all knowledge workers do a considerable amount of information handling and analysis. Planners realized that IT's biggest payoff was likely to come from improving the performance of the manager, not the secretary. Improving the performance of a \$100,000-a-year manager **will have more** impact than improving the performance of a \$30,000-a-year secretary. Although the logic for this approach makes sense, the task is difficult; managerial performance is even less tangible than secretarial performance.

The value of all these measures is in their application to provide justification for IT expenditures. In selecting a technique to describe the relationship between IT and benefits, the planner must conform to the corporate culture, its cash flow, and acceptable accounting techniques. Again, most organizations require that IT expenditures over a certain dollar amount be cost justified. Managers and IT planners consider such figures useful, especially in the following areas:

- Preparing a budget and developing long-term IT plans.
- Ensuring that IT fits into the organization's long-term business objectives.
- Developing a contract for organizational commitment of long-range expenditures.
- Prioritizing IT projects.
- Evaluating IT projects (prepared after implementation).

This chapter began by discussing problems inherent in identifying and measuring the impact that IT can have on the bottom line of an organization. IT may impact information worker performance and sales volumes. The task of correlating any IT investment with worker performance is a science, as well as an art. With this in mind, following is a discussion of techniques for tying IT expenditures to benefits. Then, quantitative techniques related to developing meaningful cost figures are offered. This chapter concludes with an overview of Information Economics (iEcon), a method for prioritizing investments in IT.

9.3 BENEFIT ANALYSIS TECHNIQUES

Many techniques used to determine the benefits and costs of IT are related to historical factory and office performance measures. From Frederick Taylor came the development of standards based on the "best" way to do something. Using this approach, stopwatches

were used to determine the best way to complete a task. In the early days of word processing, when rows and rows of typists keyed documents, worker output was actually measured line by line.

In assessing the value of information technology, such as cost savings, or value-added approaches, planners often use some of the same techniques used in establishing standards. This results in many of the same problems, particularly unreliability. A benefit figure is considered reliable if the figures are the same when the process or approach is repeated. Because of the “human element,” however, reliability among benefit figures is difficult to achieve.

Therefore, in developing cost-justification figures, the planner must choose a method applicable to the situation. When traditional methods do not work, the planner must be innovative and develop an original strategy. There is no right or wrong approach, just an *appropriate* approach.

Marilyn Parker and Robert Benson developed a taxonomy for techniques to develop benefit figures for information technology expenditures. Stemming from their work on Information Economics (iEcon), discussed later in this chapter, the taxonomy offers three types of applications within which a **specific technique can** be placed: substitutive, complementary, and innovative.⁸ *Substitutive* applications of information technology substitute technology power for people power. *Complementary* applications focus on increasing worker effectiveness. *Innovative* applications are those that are used to maintain or gain a competitive advantage. Based on the work of Parker and Benson, Figure 9-1 uses this taxonomy to categorize cost-justification techniques that will be discussed in this section.

Substitutive cost justification measures rely on traditional return on investment approaches. When IT's benefits can be tied to a particular product or product line, and measures can show specific cost savings or cost displacements, substitute techniques can be used. Examples of end-user computing applications where *substitutive* techniques are appropriate include teleconferencing (for travel) and electronic mail (for mail). A second, perhaps more creative, approach is to look for intangible values that technology adds to work and translate that value into dollars. This second approach, *complementary* techniques, includes hedonic wage models or benefit acceleration approaches. Application examples here include the use of spreadsheets, graphics, and database applications, as well as professional use of word processing. The third approach, *innovative* applications, encompasses those that are designed to maintain or gain a competitive edge. E-commerce is a good example of a category of innovative applications. Another approach is simply to explain that technology adds to the *quality of work life* or is simply the *cost of doing business*. Following is an overview of specific techniques.

9.3.1 Substitutive Techniques

The theory behind substitute techniques is simple: The cost of IT is charged against the benefits obtained from the technology. Such return-on-investment (ROI) measures are based on the premise that one can measure the “before technology” costs and compare

them with the “after technology” costs. Two strategies are used in this category: cost savings and cost displacement.

TYPE OF APPLICATION	TECHNIQUE
Substitutive	Cost savings Cost displacement
Teleconferencing	Cost savings Cost displacement
Electronic mail	
Secretarial word processing	
Complementary	
Spreadsheets	Hedonic Wage Model
Graphics packages	Applications Transfer Team
Query packages	Benefit acceleration
Innovative	
Direct customer order entry	Value added
Home banking	Innovation risk analysis
Other	Quality of work life
	Cost of doing business

Figure 9-1 Techniques for cost justification

9.3.1.1 Cost Savings

Using a cost savings approach, the planner would be able to explain that the information technology will enable a worker to do the same task at less expense. For example, suppose managers in New York City and Louisville need to meet. If the managers meet by videoconferencing rather than face-to-face, travel expenses are eliminated. The planner can justify the projected costs of the videoconference by comparing its cost with the projected travel expenses:

Business class airfare for two executives	\$1,500
Ground transportation	200
Hotel accommodations (two nights) in New York City	1,200
Food expenses	500
<i>Total</i>	<i>\$3,400</i>
VIDEOCONFERENCING COSTS	
Hardware purchases	300
Transmission time	40
<i>Total</i>	<i>\$340</i>

This cost comparison shows that the audio conference would be much less expensive than the travel (\$340 as compared to \$3,400). A creative planner could even put a dollar amount on the time that the executives who are traveling would be away from their desks and not doing other productive work for the organization. Although this approach is simplistic, it can be effective in developing a cost justification argument.

9.3.1.2 Cost Displacement

Historically, office technology was justified in terms of cost displacement or cost avoidance. Using a \$20,000 word processor, a typist could do the work of three typists, thus reducing personnel costs by two workers. In the 1960s and 1970s, office automation

was word processing. Most planners justified the expense by decreases in the number of secretaries. If secretaries were paid \$20,000 per year (including fringe benefits), the purchase of a word processor would displace personnel expenses of \$40,000.

Interestingly enough, as the number of secretaries was reduced, much of the clerical work of proofing, copying, and “goforing” was inadvertently offloaded onto managers and professionals, who were paid two or three times as much as the secretaries. Thus, cost displacement strategies must be applied cautiously to avoid achieving savings in one area at the expense of another. Performance is increased only by improving the effectiveness of the entire system.

9.3.2 Complementary Techniques

Complementary techniques discussed here are Hedonic Wage Model analysis, IBM’s Applications Transfer Team approach, and the benefit acceleration model.

9.3.2.1 Hedonic Wage Model

Sassone and Schwartz’s Hedonic Wage Model is a two-part procedure that first measures work and then applies dollar values to that work.⁹ This procedure requires the planner to first identify employee classifications (manager, administrator, senior professional, junior professional, technician, and secretary). An average (or actual) hourly wage is determined for the employee. In addition, specific tasks are assigned certain values for certain classifications. Then, individuals in these positions are asked to use a work log to detail their activities. As shown in Figure 9-2, activities are classified according to the value of the activity, and then are applied to the wages received for the activity. This procedure can serve as a pretest, describing “work” before technology, and as a posttest to describe “work” after the new technology is implemented.

9.3.2.2 Applications Transfer Team

IBM’s Applications Transfer Team method is based on identifying shadow functions. To help potential customers identify the type and amount of technology desirable, IBM planners help their customers estimate the time they spend on specific tasks such as writing, reading, looking for files, or answering the telephone. Gains are measured by calculating the time saved by performing these tasks more efficiently.

For example, a strong case could be made for voice mail as a means to eliminate unscheduled meetings and taking messages from calls. A \$90,000 executive who works 40 hours each week, 50 weeks each year, would earn \$1,800 per week, \$360 per day, or \$45.00 per hour. Two hours saved each week (\$90) for 50 weeks equals a savings of \$4,500 for this employee alone.

9.3.2.3 Benefit Acceleration Model

Benefit acceleration model analysis has its roots in economics rather than in business finance. Parker and Benson explained that it is appropriate to use when the effects of IT can be linked to specific outcome measures through increased revenues or decreased

costs.¹⁰ For example, an information center can be cost justified by explaining that a center could help the organization achieve its financial objectives faster or better than by traditional means. This is *not* the same argument that an in-forma-tion center would help keep operating costs or labor costs low, as in cost savings approaches.

EXAMPLE BENEFIT CALCULATION FOR MANAGERS IMPLICIT				
WORK CATEGORY	VALUE (HOURLY)	INITIAL HOURS*	FINAL HOURS**	VALUE
Management	\$83.99	600	700	\$8,399.00
Specialist professional	\$65.11	320	400	\$5,208.80
Routine professional	\$48.75	260	300	\$1,950.00
Administrative	\$41.15	320	300	(\$823.00)
Clerical	\$20.90	140	100	(\$836.00)
Nonproductive	0.00	360	200	\$0.00
TOTALS		2,000	2,000	\$13,898.80
*Pre-System				
*Estimated Post-System				

Source: Sassone and Schwartz.

Figure 9-2 Hedonic Wage Model

9.3.3 Innovative Technique

Two innovative techniques are discussed here. The first technique is value added. The second approach is innovation risk analysis. While the value-added technique could be described as complementary, because it includes an emphasis on doing work creatively, it is considered innovative.

9.3.3.1 Value-Added Techniques

Value-added techniques put a dollar figure on the value of work done by information technology by making one or more of the following determinations:

1. Determining the activities that were done by the information technology that could not have been done if the technology had not been available.
2. Determining how much more work was done as a result of the information technology
3. Determining how much the quality of output increased as a result of using new information technology. (For example, were better or more timely decisions made because information was more accurate or more quickly compiled?)

In *The Information Edge*, N. Dean Meyer and Mary Boone offered more than 50 cases in which IT measurably enhanced profits. For example:

- a spreadsheet made \$76 million for a chemical company
- electronic mail got a product to market two months early, with a ROI of 1,000 percent
- a \$600 search of public information data banks made a material difference in an \$18 million lawsuit¹¹

Meyer and Boone offer creative methods to perform cost justification and IT performance auditing. In short, the method is for the planner to work with the user to

determine the impact of IT on behavior, the benefit of that impact, and the value of that benefit to the organization's overall strategy.

9.3.3.2 Innovation Risk Analysis

Innovation risk analysis is used to evaluate information technologies and choose alternatives. Important considerations related to innovation risk analysis are identifying the cost of being the first to have a technology and the value of (any) competitive advantage the technology may offer. Also considered in the analysis are the costs involved should the technology application fail.¹²

Performance/Satisfaction Survey							
<p>Following is a list of work situations that may impact your productivity. Pick the eight that are most important to you. Rank them from 8 (most important) to 1 (least important). Write rankings to the left of items in the "P" column.</p> <p>Then, pick the eight items you feel are most important to your personal on-the-job satisfaction. Rank them from 8 (most important) to 1 (least important). Write these rankings in the "S" column.</p> <p>Indicate the degree to which you experience each situation as an impact of using the new product ordering system. Larger numbers indicate more effect. Judge the degree of effect independently from the importance you attach to each item.</p>							
PS	PS	WORK SITUATION	EFFECT TECHNOLOGY				
			HIGH			LOW	
_____	_____	Faster reaction to problems/ opportunities	4	3	2	1	0
_____	_____	Improved quality of work	4	3	2	1	0
_____	_____	Increased control over operations	4	3	2	1	0
_____	_____	Decrease in time needed to do work	4	3	2	1	0
_____	_____	Better personal organization	4	3	2	1	0
_____	_____	Reduced interruptions	4	3	2	1	0
_____	_____	Reduced time spent on clerical tasks	4	3	2	1	0
_____	_____	More creativity	4	3	2	1	0
_____	_____	Reduced mistakes	4	3	2	1	0
_____	_____	Clearer communications	4	3	2	1	0
_____	_____	More rapid communications	4	3	2	1	0
_____	_____	Increase in accuracy of data	4	3	2	1	0
_____	_____	Increase in amount of data	4	3	2	1	0
_____	_____	Improved access to needed data	4	3	2	1	0
_____	_____	Reduced waiting for information	4	3	2	1	0
_____	_____	Data in more understandable form	4	3	2	1	0
_____	_____	Improved decision making	4	3	2	1	0
_____	_____	Better planning	4	3	2	1	0
_____	_____	Timely completion of work	4	3	2	1	0
_____	_____	Additional work undertaken	4	3	2	1	0
_____	_____	Less overtime	4	3	2	1	0
_____	_____	Less waiting for work	4	3	2	1	0
_____	_____	More job satisfaction	4	3	2	1	0
_____	_____	Increased motivation to work	4	3	2	1	0
_____	_____	Cost reduction	4	3	2	1	0
_____	_____	Other _____	4	3	2	1	0
_____	_____	Other _____	4	3	2	1	0

Figure 9-3 Productivity/job satisfaction survey

1. How much time do you use the new system per day					
2. Compared to the way you used to do your work, does using the system save you time on an average day? Yes No Sometimes					
If you answered "yes" or "sometimes,"					
2a. How does the system save you time?					
2b. What do you do with the time saved?					
2c. Are there any negative effects of using the new system? What are they					
	High				Low
3. Rate your overall degree of satisfaction with the system	4	3	2	1	0
4. Rate your skill level in using the system	4	3	2	1	0
Please check your job classification	_____	Secretary/Clerical			
	_____	Professional			
	_____	- Manager			
	_____	Supervisor			
	_____	Director, VP, GM			
	_____	Other			
Please add any comments on the back of this sheet. Thank you					

Figure 9-3 (continued)

9.3.4 Other Approaches

Two old techniques that are used increasingly in justifying information technology expenditures are *quality of work life (QWL)* and *the cost of doing business* techniques.

9.3.4.1 Quality of Work Life Approaches

IT's value also can be determined by assessing the quality of work life. Are workers who are using technology able to do routine activities with ease, thus freeing them for more creative, more rewarding activities? If so, information technology has made a contribution to their quality of work life (QWL).

To develop a measure of QWL, Figure 9-3, Productivity/Job Satisfaction Survey, is offered. This survey was used by a major vendor to determine if (and how) IT affected the worker's perceived performance and job satisfaction. While the problem remains of how to put a dollar figure on QWL, such data are valuable because factors that contribute to performance are often the same as those that contribute to job satisfaction.

Other measures may require using historical data to determine that turnover rates have changed since the technology was introduced. Despite its difficulty, another measure may be to document that *better* employees were attracted to the organization because of the technology. Of interest, employers who hire people directly from business schools are finding that a state-of-the-art PC connected to the Internet is the prospective employee's expectation and is part of the hiring agreement.

9.3.4.2 The Cost of Doing Business

This third and final argument for persuading managers to invest in IT is simple:

The organization cannot go on without it! Sometimes danger exists in bureaucracies where every purchase is suspect and must be justified. Creativity and performance may be stifled when long delays occur between identifying a technological solution for a

problem and implementing the technology. In some cases, the task to be done cannot be done without technology. In other cases, the technology improves customer service. Perhaps the most convincing of arguments is that use of the technology gives the organization a competitive edge.

These arguments have been discussed in previous chapters and may be the route that IT justification will take in the future. As business school graduates who negotiate for a computer as part of their hiring contract know, IT is often just the way that work should be done. IT can be related to performance via better customer service. Good service results in repeat customers, which equals more sales, which equals more profit. The third situation, where IT gives the organization a larger share of the market because marketing was innovative or orders were processed and shipped more quickly, is of undescrivable value.

SPOTLIGHT ON SOLUTIONS →Technology, People, Structure, Processes

THE COST OF DOING BUSINESS

- Tom Hall, manager of electronic commerce for Michelin North America, said an immediate, monetary return-on-investment (RO!) was not among the chief goals of an initiative to provide electronic-commerce links between Michelin and the 1,0(X)-plus dealers who sell the company's tires throughout North America. The primary objective, Hall said, was improving relationships between Michelin and its dealers, something the company believed it had to do in order to keep those dealers as long-term customers. The project was launched after a customer service study revealed that the dealers thought Michelin had excellent products and a knowledgeable sales force, but the company was difficult to do business with and was particularly slow at responding to dealer problems.
- Shawn Carson echoed that sentiment in speaking about the implementation of a front-office customer interaction application at Computational Systems (CSI), an \$80 million-a-year manufacturer of reliability analysis equipment based in Knoxville, Tennessee, where he is director of customer services. The new system provides a smooth flow of information throughout the organization, which has eliminated what Carson described as a recurring problem of CS! salespeople visiting customer sites and "being blindsided" with questions about unresolved problems that had been reported to customer service. In addition to making customer visits more pleasant, Carson said the new system allows salespeople to spend more time with customers by automatically performing administrative tasks such as producing mailing lists. It also has helped CS! get a better return on its marketing dollars by identifying which promotions generate the most sales. Overall, Carson says, the system has helped boost sales by roughly 10 percent through more efficient customer management.
- An insurance company wanted to invest in a decision support system to help claims assessment using a workflow package. The investment would cost \$2 million, and using certain benefits and the net present value calculations, they were able to say that the project would lose \$250,000. But they then identified uncertain benefits, often called intangibles, which added up to \$3 million. One intangible was faster training for new claims assessors. Another would be a more consistent face to their customers. A third would be capturing the knowledge of what makes good claims and building it back into the system. Now this last was a very uncertain benefit but a very attractive one. The IT investment board said this system met their business maxims. They realized they would lose \$250,000 on tangible benefits, but they could get back \$3 million on intangibles. And they asked themselves whether they were prepared to pay the \$250,000 they would lose on the project for the chance of getting those intangibles. That's how you make the decision. This company recognized that the knowledge management piece was very risky, and they wanted to do a pilot on it. They decided to double the amount of money for project management of this very risky project. That's good practice. And that's how companies manage an IT portfolio.

Source: Sidney Hill, "More Than a Number," *Manufacturing Systems* 16(1998): 10—11. Reprinted with permission.

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9.4 COST ANALYSIS TECHNIQUES

Important to consider in a discussion of cost justification techniques is that the cost of technology is falling rapidly. Many line managers have budgetary approval for items that are, say, less than \$3,000. Much hardware and software costs less than this figure, and line managers approve such expenditures routinely. This ability to cut through the red tape of the capital expenditure process in an organization is considered desirable by departments (although sometimes not so desirable by any centralized information technology group). The point here is that although quantifying inputs and outputs is not always necessary, determining prospective *value* to the end user remains important.

Titman argued that costs are top-heavy when inputs have large overheads that are then allocated directly to labor costs.¹³ The emphasis in this section is on costing, which involves putting dollars on the price of technology. While accepted accounting techniques exist for this process, keep in mind their strengths and limitations when attempting to measure the costs of information technology.

IT planners have been innovative in estimating the cost benefits of technology. Likewise, they continue to be innovative in using tactics borrowed from accounting practices to develop realistic technology costs. Accounting techniques can be used to develop more realistic cost figures or to expense the technology over time. Selected techniques discussed in this section include: (1) salvage value; (2) depreciation; (3) payback period; (4) total-life averaging, (5) return on investment; (6) net present value; and (7) purchasing versus leasing/renting.

9.4.1 Salvage Value

Salvage value, or the value of the equipment being replaced, often is overlooked when cost figures are developed. For example, if the information technology planner can trade in or sell existing equipment, the value of the existing equipment can decrease the cost of the new equipment. If a microcomputer that costs \$5,000 is assumed to have a useful life of 3 years (3 years is the norm), but it is anticipated that it may be sold at the end of that period for \$1,500, the cost may be lowered to \$3,500. The expected salvage value of this microcomputer is \$1,500. This approach is used to reduce the initial cost figure.

9.4.2 Depreciation

The accounting concept of depreciation spreads the cost of equipment over its expected life span. *Depreciation* may be likened to rent expense; in other words, the cost of equipment is expensed over a period equal to how long it is expected to be operational. Two depreciation approaches are *straight line* and *sum-of-the-year's digits*.

The straight-line depreciation method decreases the cost of technology by spreading its costs evenly across its useful life. It also may assume that the technology has a salvage value. For example, assume that a \$25,000 system has an expected 5-year life span and a \$5,000 salvage value. A straight-line formula for this situation, using a straight-line approach, is illustrated in Figure 9-4. Using this method, the planner may find that the \$4,000-a-year figure may be more useful than the one-time but much larger \$25,000 figure.

Original cost of equipment — Estimated disposal value ÷ Years of useful life = Depreciation
Example: A \$25,000 piece of equipment with a salvage value of \$5,000 and an expected life of 5 years can be “expensed” as \$25,000 — \$5,000 ÷ 5 = \$4,000 yearly depreciation expense.

Figure 9-4 An example of the straight-line method for computing yearly depreciation

Because the value of technology often declines rapidly in its initial years, an alternative depreciation technique is sum-of-the-year's digits. The assumption is that the organization will get the most value from the system the first year it is in operation, and its value will fall and then totally diminish in remaining years. No salvage value is assumed. Figure 9-5 shows how the same \$25,000 expenditure described in the straight-line example could be “expensed” by the sum-of-the-year's-digits method.

While using a sum-of-the-year's-digits approach results in first-year expenses that are larger than the straight-line approach, its use is appropriate to IT expenditures because only rarely do systems have identifiable resale value. A planner attempting to cost-justify technology would need to determine if a lower or higher first-year cost figure would be realistic and convince decision makers of the viability of the purchase.

Both of these depreciation techniques are acceptable accounting practices. The planner must choose. The choice of one of these (or another) depreciation methods may depend on the organization's accounting policies and/or government regulations.

9.4.3 Payback Period

Calculating a *payback* (or payout) *period* is a commonly used technique in business. It is favored because of its straightforward calculation and ease of interpretation. However, it may not always give a realistic picture. Intangible costs may be ignored, for example, or the enterprise may not realize the full benefits of a new system until several years into implementation. Payback period does not take into consideration factors other than cost, such as the risks involved in implementing a project. Nor does it provide a basis for comparing alternative projects.

Related to cost displacement, the payback period shows how long it will take an investment to pay for itself, or break even. This technique involves the following steps:

1. Calculate projected system development costs.
2. Calculate expected annual operating costs with new system.
3. Calculate annual operating costs of current system.
4. Subtract operating costs of new system from costs of current system to calculate projected annual operating cost savings.
5. Divide the projected system development costs by the projected annual operating cost savings to calculate the payback period (in years).

- $1+2+3+4+5=15$

The deprecation figures, then, could read as follows:

- Year 1 ($5/15 \times 20,000$) = \$6,600
- Year 2 ($4/15 \times 20,000$) = \$5,400
- Year 3 ($3/15 \times 20,000$) = \$4,000
- Year 4 ($2/15 \times 20,000$) = \$2,600
- Year 5 ($1/15 \times 20,000$) = \$1,400
- Total \$20,000

Figure 9-5 An example of the sum-of-the-year's-digits method for computing depreciation

Yearly cost of traditional seminars	=	\$250,000
Yearly cost of teleconference seminars	=	100,000
Yearly operating cost savings	=	150,000
Cost of videoconferencing system	=	450,000
Payback period = 450,000/150,000	=	3 years

Figure 9-6 An example of the payback period method for computing technology cost figures

Assume that the yearly cost of updating a sales force on new products via traditional seminars is \$250,000. If a videoconferencing system could do the task at an annual operating cost of \$100,000, but with an initial cost of \$450,000, the planner would calculate the payback period by dividing the initial development cost of \$450,000 by the projected annual operating cost savings of \$150,000. Thus, the pay-back period would be 3 years. This formula is depicted in Figure 9-6.

The example in Figure 9-6 is simple for illustrative purposes. In reality, the analyst may find that implementation costs are spread over more than 1 year and that operating costs will vary over the payback period. The calculation then might be broken out year by year over several years. The example in Figure 9-7 shows a possible calculation for a project with initial development costs of \$100,000 and an anticipated system life of 5 years. Note that the break-even point would occur just prior to year 4. The payback analysis for a 5-year period involves the following steps:

1. Estimate net operating cost for period.
2. Estimate expected benefits for period.
3. Calculate cumulative costs and cumulative benefits.
4. Compare cumulative costs to cumulative benefits. The year in which the cumulative benefits match or exceed the cumulative costs is the break-even point for the installation.

Does the example in Figure 9-7 indicate a good or bad investment? The answer depends on the payback expectations of the project sponsor. If the guideline were 5 years, the project could be considered a desirable investment. If the payback criteria for projects were 2 years, however, then the project probably would not be considered a good investment.

YEAR	0	1	2	3	4
Development cost	100,000				
Operating cost		5,000	5,000	6,000	7,000
Cumulative cost	100,000	105,000	110,000	116,000	123,000
Expected benefits		30,000	35,000	55,000	70,000
Cumulative benefits		30,000	65,000	120,000	190,000
(break even 4 years)					

Figure 9-7

Payback analysis for 5-year period with an initial investment of \$100,000

9.4.4 Total Life Average Method

Every capital cost brings with it revenue costs that last for the rest of the item's life. The corollary to this rule is that these extra costs are never less than one expects them to be.¹⁴

The *total life average method* for justifying IT expenditures is related to the cost savings strategy discussed earlier in this chapter. Total life averaging involves summing all expenses related to purchasing and operating a piece of equipment. For example, the cost of a new software package might include its retail price, the anticipated costs of upgrades, transferring data using the current package to the new package, and end-user training. That comprehensive cost figure then is divided by the estimated life of the equipment.

For larger expenditures, such as a companywide voice mail system, the total could include all costs, including interest (if the money is to be borrowed), opportunity costs (loss of income if the money had been invested elsewhere), and salvage value, as well as all operating costs.

The planner may find this approach useful when comparing two different systems or when justifying new technology because the existing technology has expensive maintenance or supply costs. The example in Figure 9-8 illustrates that maintaining the existing copier is less cost effective than replacing it.

9.4.5 Return on Investment (ROI)

ROI compares the projected lifetime benefits, or savings, of alternative solutions based on a percentage rate that represents the expected return on the cost of implementing a new system. The solution offering the highest return on investment is the best alternative. However, a project sponsor may have guidelines governing an acceptable ROI for all investments. In this case, minimum acceptable ROI becomes the platform for comparison, and none or all of the alternative solutions may be accepted or rejected.

The formula to calculate this rate of return is the projected lifetime benefits minus the projected lifetime costs divided by the projected lifetime costs. The formula is shown in Figure 9-9. Using the example for the payback analysis in Figure 9-7, the ROI would be calculated as follows:

$$ROI = \frac{190,00 - 123,000}{123,000} = \frac{67,000}{123,000} = 54\%$$

EXISTING COPIER		NEW COPIER	
Monthly maintenance fee	\$120	Monthly maintenance fee	\$50
Monthly supplies and toner	\$200	Monthly supplies and toner	\$100
Monthly deprecation costs	\$100	Monthly depreciation costs	\$200
Monthly down hours	20	Monthly down hours	0

Figure 9-8

An example for the total life average method for computing cost figures

$$ROI = \frac{\text{Projected Lifetime Benefit} - \text{Projected Lifetime Cost}}{\text{Projected Lifetime Cost}}$$

$$\text{ROI} = \frac{190,000 - 123,000}{123,000} = \frac{67,000}{123,000} = 54\%$$

$$\text{ROI} = \frac{\text{Projected Lifetime Benefit} - \text{Projected Lifetime Cost}}{\text{Projected Lifetime Cost}}$$

$$\text{ROI} = \frac{190,000 - 123,000}{123,000} = \frac{67,000}{123,000} = 54\%$$

Figure 9-9

Return on investment analysis (ROI) method for determining technology benefits

If this calculated percentage is compared to the ROI for alternative projects, the alternative with the highest ROI would be the best investment.

ROI has its drawbacks, however. The rate of return is an average rating. The actual ROI may vary over the lifetime of a system. This method also does not consider the time factor (the fact that the ROI in earlier years may be less than in later years or vice versa).

9.4.6 Net Present Value (NPV)

Net present value (NPV) takes into consideration the time value of money and allows the analyst to compare alternatives that have different costs, benefits, and discount rates. For this reason, it is often the preferred justification method among managers with strong business finance expertise.

SPOTLIGHT ON SOLUTIONS → Technology, People, Structure, Processes

ROI CALCULATION EXAMPLES

- Assume that a remote campus generates performance calls to the Help Desk that cost \$10,000! month (20 calls/day X 20 business days X \$25! call). An upgraded network connection will cost \$8,000 per month (\$72,000 capital/36 months plus \$6,000 recurring monthly costs). The return is \$2,000 on an expense of \$8,000, so the ROI is .25 percent
- A daily production order is sent every morning to a factory management system that must have all the orders to calculate the detailed work flow. Each order takes 5 seconds to transfer. On normal days, this system works just fine, but on some days network congestion adds 10 seconds to each order. Because there are typically 1,000 units, this translates to a 2.8-hour delay of production. It costs the company \$10,000 per hour to operate the factory so each Incident costs nearly \$30,000. When such incidents climb to about one per month, an upgrade that costs \$20,000 per month would be considered a good investment, because it will generate a 50 percent ROI
- A shipping firm has to get its ships containing highly perishable food through the Panama Canal on a regularly scheduled basis. The ship's manifests which detail everything being carried, must be presented to Canal authorities just as the ship approaches the Canal. If the manifest is incomplete, the ship is sent to the end of the line, which means a 5-day delay. If this were to happen even once, it would be catastrophic for the company, so it was easy to justify a faster system that could deliver the manifest as the ship left the last port-of-call before the Canal.

Source: Peter Sevcik, "Customers Need Performance-Based Network ROI Analysis," *Business Communications Review* 29(1999): 12-14

NPV takes into account the fact that some of the costs and all benefits of a new system will be accrued in the future. Therefore, when doing a cost—benefit analysis, projected dollar values should be brought back to *present value dollars*. NPV is

calculated by determining the costs and benefits for each year of a new system's projected lifetime. The costs and benefits are adjusted based on a present value factor. The adjusted costs and benefits are then compared. The formula for calculating NPV is:

$$\frac{1}{PV_n} = (1 + i)^n$$

where PV is the present value of \$1.00, n equals number of years from now, and i equals discount rate.

Therefore, the present value of a dollar 2 years from now with a discount rate of 12 percent is:

$$PV_2 = \frac{1}{(+0.12)^2}$$

For example, suppose a proposed system was projected to realize a benefit of \$40,000 in 2 years and the current ROI is running 10 percent. It would take an investment of \$33,056 today to give us the \$40,000 estimated benefit 2 years from now. The NPV of the estimated benefit is, therefore, \$33,056. See Figure 9-10 for the calculation of NPV for the same example used for the payback analysis in Figure 9-7.

9.4.7 Purchasing Versus Leasing or Renting

Purchasing is buying equipment outright. *Leasing* is a contractual agreement to use a piece of equipment for a given amount of time. *Renting* is buying the use of it for an unspecified time. Sometimes, it makes good business sense to lease or rent equipment rather than to purchase it outright. In addition to decreasing immediate, out-of-pocket expenses, leasing or renting puts responsibility for upkeep and repairs on the manufacturer or dealer.

YEAR	0	1	2	3	4
Development costs	\$100,000	0	0	0	0
Operating costs		\$ 5,000	\$ 5,000	\$6,000	\$ 7,000
Discount rate at 12%	1.000	0.893	0.797	0.712	0.636
Present value	100,000	4,465	3,985	4,272	4,452
Total costs					\$ 17,174
Benefits	0	30,000	35,000	55,000	70,000
Discount rate at 12%		0.893	0.797	0.712	0.636
Present value		26,790	27,895	39,160	44,520
Total benefits					\$138,365
NET PRESENT VALUE					\$121,191

Figure 9-10

Net present value: a project with initial development costs of \$100,000 and an expected life of 5 years

It also protects the consumer against product obsolescence; when a newer or better model comes on the market, it is easier to upgrade. Renting or leasing spreads the cost of equipment over its useful life to the organization; it is, unnecessary to develop life estimates. Perhaps most important, renting or leasing is usually a fully deductible operating expense.

Deciding whether to purchase, lease, or rent information technology hardware requires the planner to assess pros and cons of ownership. Advantages of Ownership must be weighed against the advantages of renting or leasing.

9.5 INFORMATION ECONOMICS

A comprehensive methodology for valuing and comparing investments in information systems, *Information Economics (iEcon)*, takes a much broader approach than traditional ROI or cost-benefit analysis. Although typically used within large systems projects, iEcon can be used as a method to compare EUIS projects among themselves or against other information technology projects.

iEcon suggests that an expanded definition of *value* is needed to measure the relative worth of individual information technology projects and their impact on the business. This definition of value encompasses both *hard* and *soft* benefits and costs. Taken together, these hard and soft measurements give a better picture of exactly how information technology projects will affect the business. The *hard* costs are those project elements that are quantifiable. In addition to normal return on investment calculations, Information Economics uses several advanced techniques to compute the hidden economic benefits and costs of a project. The *soft* component of value includes the intangible benefits and costs of a project. Although these intangible elements are not convertible to dollar figures, they are often critical in determining a project's value to the enterprise. Some of these criteria include:¹⁵

Strategic Match	The relative benefits derived from supporting the business strategy
Competitive Advantage	The relative advantage in the marketplace gained from applying IT.
Technical Uncertainty	The relative risk involved in undertaking projects using unproven technology.
Strategic IT	The relative benefit derived by having a project that will allow other projects to occur.
Enterprise CSFs	The relative benefit derived when the project achieves a critical success factor (CSF) bearing on enterprise performance.

A problem facing information systems professionals and line managers is whether a particular information systems project should be done, and from among the many projects that could be done, which project(s) should be given priority. iEcon's assessment strategy helps decision makers link information technology to business

goals. The actual implementation of an Information Economics-based analysis involves top management from both the business and information systems (technology) units. These top managers identify financial concerns and organizational goals. The information systems specialists and middle managers select criteria from among those listed above and analyze each criterion as to how it contributes to the organization's goals. The dual goal of this process is to tie the value of IS projects to the enterprise goals, and then help managers and IS specialists prioritize projects.

The essential process for information systems professionals and managers can be summarized as follows:

1. In addition to determining return on investment figures (discussed earlier in this chapter), determine which *value* criteria are appropriate (strategic match, competitive advantage, technical uncertainty~ strategic architecture, and/or enterprise CSFs).
2. Using a scale of 1 to 5, assess the relative advantage of each criterion. "Five" would represent the highest possible benefit to an organization; "zero" would have no impact.
3. Rank the projects. Criteria can be weighted; for example, when finances are tight, the strategic advantage criterion may be worth twice the value of strategic IT architecture.

Figure 9-11 depicts these essential concepts in action. Assume decision makers need to determine which of three projects will provide the most value to their organization, and therefore should be given the highest priority. The specific projects (e.g., electronic mail, a document management system, and an electronic meeting system) are listed in the first column. Managers and information systems professionals assess the relative value of each specific project to their organization on each of the identified criteria. The *relative values* of the project, based on ROI and the established criteria are then assessed on a 1 to 5 scale (5 high benefit; 3 medium benefit; 1 = low benefit). These values are listed under the heading "Values" and summed for each project. The composite scores are the basis for the initial rank ordering. In this example, e-mail and electronic meeting systems tie for first place.

While these projects appear to be the most opportune projects to begin based on an initial ranking, iEcon suggests that the contribution of each project in terms of the organization's overall investment strategy also should be examined. To do this, a weighting can be spread so that the assigned criteria get different scores. One way to do this is to assume you have \$1 to spread across the various projects. How would you allocate that dollar? In Figure 9-11, under *Strategic Investment Profile*, the value of each criterion as compared to other criteria is shown. ROI was given a value of \$0.40; strategic match, \$0.30; competitive advantage, \$0.10; and strategic information technology infrastructure, \$0.20. These respective weights multiplied against the earlier ratings result in a different priority listing. Because top management sets the investment strategy of the business, investment in the electronic meeting system is a better match at this point than the other projects.

VALUES					
PROJECT	ROI	SM	CA	IT	RANK
E-mail	4	3	3	5	(15)1
Electronic meeting sys.	5	4	5	1	(15)1
Document mgt.	1	5	3	5	(14)3
<i>Strategic Investment Profile</i>					
VALUES					
PROJECT	ROI (0.40)	SM (0.30)	CA (0.10)	IT (0.20)	RANK (\$1)
E-mail	4X0.4=1.6	3X0.3=0.9	3X0.1=1.6	5X0.2=1	(3.8)2
Elec. meet. sys.	5X0.4=2.0	4X0.3=1.2	5X0.1=2.0	1X0.2=0.2	(3.9)1
Doc. mgt.	1X0.4=0.4	5X0.3=1.5	3X0.1=0.4	5X0.2=1	(3.2)3
ROI= Return on investment SM = Strategic match CA = Competitive advantage IT = Strategic I/T architecture					

Figure 9-11 Information Economics: essential concepts applied

9.6 SUMMARY

Knowledge worker productivity is difficult to measure because input and output figures are difficult to establish. Even when numbers can be applied, the productivity formula ($P/O/I$) does not consider quality or effectiveness of output. Likewise, input figures are difficult to establish. Therefore, performance measures were offered as a more useful measure.

Assuming that performance can be measured or rated, the challenge is to assess its dollar value. Such figures are often the basis for selling top management on the desirability or need for new technology. Although it appears that business is evolving to the point where technology is simply the cost of doing business, planners often need cost-justification figures to help them prepare budgets that include IT in the long-range plans of the organization and ensure commitment for long-range expenditures. Cost justification figures also are used as a basis for prioritizing IT projects and for evaluating results following implementation.

Parker and Benson's taxonomy of benefit calculations was used as a framework for a discussion of quantitative techniques to put hard dollars on benefits gained through the use of information technologies. *Substitute* techniques included cost savings and cost displacement. *Complementary* applications included the Hedonic Wage Model, Applications Transfer Team, and benefit acceleration. *Innovative* techniques were valued added and innovation risk analysis. Other approaches included QWL and the cost of doing business. It should be stressed that several of these techniques commonly are combined. Choosing an appropriate technique requires careful analysis of the situation,

including the organization's history needs, cash flow, and standard accounting procedures and policies.

Technology costs also must be quantified. Accounting techniques can help the planner develop meaningful cost calculations. Such techniques include but are not limited to salvage value, depreciation, total-life averaging, return on investment, net present value, and purchasing versus leasing/renting.

The chapter included a discussion of Information Economics, a method of measuring value and prioritizing projects by measuring hard and soft IT benefits. Benefits used to determine IT's value to the enterprise include those derived from IT's relation to strategic match, gains from competitive advantage, the risk of technical uncertainty, support of a strategic IT architecture, and the achievement of enterprise critical success factors.

In short, measuring worker performance and analyzing costs and benefits of IT is an inexact process, but because of the considerable expense in hardware, software, maintenance, and user training, IT cost justification is a requirement in most organizations today. The strategies outlined here overview some accepted approaches. Determining the best cost justification approach depends on many *factors*, including the strategic value of the technology, the overall impact of the technology, and the costs involved.

KEY TERMS

- Cost displacement
- Depreciation
- Effectiveness
- Efficiency
- Hard dollar
- Information Economics
- Leasing
- Net present value
- Payback period
- Performance
- Productivity
- Quality of work life (QWL)
- Renting
- Return on investment (ROI)
- Salvage value
- Shadow functions
- Soft dollar
- Standard
- Total-life-average method
- Value added

DISCUSSION QUESTIONS

1. What is productivity? Why is it so difficult to measure the productivity of knowledge workers?

2. What is performance? Why is performance often used as a substitute for productivity?
3. To justify the purchases of the following technologies, what approach might the information technology planner take? Defend your answers.
 - a. An Intranet
 - b. A color laser printer/fax/copy machine
 - c. An electronic meeting management system
 - d. A project management system
 - e. A value-added reseller (VAR) to manage data backup and security
 - f. An upgrade from Office 2000 to Office 20XX
 - g. A move to e-commerce
4. Assume that you, the EUIS planner, have determined that your organization could benefit from a \$100,000 group support system. Of the accounting techniques described in this chapter, which would you use to calculate cost savings? Using this \$100,000 figure, show how you would use the technique. You will need to develop your own figures for other variables required in this exercise.
5. Summarize, in your own words, the concepts behind Information Economics (iEcon) as a planning methodology.
6. If performance measures and IT costs and benefits are so difficult to determine, why is it done? Does the process offer any benefits to IT planners? Discuss.

APPLICATION EXERCISES

1. Interview an accounting professor for his or her views on what's appropriate for cost-justifying IT expenditures. What techniques does the professor offer that expand on those in this text?
2. Write a report comparing Japanese with American views of workers' productivity
3. As a class project, each student should interview a person who recently has begun using a new information technology. How pleased is the person with the new technology? Does he or she view it as a performance enhancer? If so, in what way? Compare the results of your interview with what your classmates found. Are answers consistent? Why or why not? Is the length of 'time a person has been using the technology important in the response?

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